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TOXICOLOGY.—*Toxicity of some dinitrophenols to the American dog tick*, Dermacentor variabilis (Say).[1] OSCAR E. TAUBER, ANNE HAGER TAUBER,[2] CHARLES R. JOYCE,[2] and WILLIS N. BRUCE. (Communicated by CARL J. DRAKE.)

Pastac (11) indicates, without reference or date, that the first notice of the value of a nitro dye as an insecticide came through the observation that clothes moths did not molest wool dyed with martius yellow (dinitronaphthol). In the past 30 years a considerable number of laboratory and field tests with many dinitrophenols have been conducted on a number of different insects (3, 7, 8, 8a, 9, 9a, 10, 11, 12, 13, 14, 15). Some of these same dinitro compounds have been recommended as weedkillers, fungicides, etc. (2, 6, 11, 17). No records of the effects of any dinitrophenols on ticks have been found.

Ticks are particularly concerned in the transmission of relapsing fever and typhus-like diseases. Recently (1942) Anigstein and Bader (1) reported evidence suggesting *Amblyomma americanum* as an additional carrier of Rocky Mountain spotted fever. At this writing, when military training and actual warfare bring many thousands of men into possible contact with various potentially dangerous Ixodidae, any suggestions that may contribute to methods for extermination of ticks should prove timely.

Ticks are very tenacious of life. Past attempts at control and eradication have involved such laborious procedures as mechanical removal by handpicking or entanglement in sheep wool; dipping domestic animals; cutting or burning tick infested brush; or by trapping, poisoning, or shooting of hosts other than man and domestic animals. Since these hosts sometimes also include such active forms as bats and birds, the last three of the enumerated methods of eradication are hardly possible or efficient. Also, elimination of rodents or other wild hosts over a large area is likely to upset some biologic balance and initiate new problems of another nature.

The experiments to be described were begun as preliminary ground-work for contemplated field trials to kill ticks in selected areas by dusting vegetation in which they are concentrated. Such dustings might reach the ticks directly as they rested on the vegetation or crawled on the ground. It might reach them when their wild hosts, such as mammals and ground-feeding birds, moved through the dusted herbage and brushed and shook the toxic material on themselves and their parasites. So far as we can determine, this proposed approach is a new attack on the tick problem.

Should this dusting of vegetation prove of value in killing ticks, such a technique might be useful in reducing populations of mosquitoes, chiggers, certain flies, and other forms that rest on herbage, or wait for victims while hanging on grass, shrubs, or other plants. The method might conceivably be the answer to ridding jungle trails of blood-sucking land leeches, which are a real

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menace to travelers and soldiers in Indo-China, Malaya, and other areas of that region where rainfall is especially abundant. "Blanket" dusting of refuse piles and dumps may also serve to bring the toxic dusts to fleas and lice carried by rats.

With these and other ideas of control in mind, preliminary tests on fleas and other pests have been inaugurated to ascertain killing doses before field work is begun. These latter results will be published in subsequent papers.

CHEMICALS

Whenever possible, toxic compounds were obtained as pure chemicals and diluted as desired in the laboratory. To insure thorough dispersal, weighed ingredients were first mixed by spatula on a glass plate, then shaken in a large jar, and last placed on a home-made "roller-ball-mill" by which a cylinder, containing the mixture and pebbles or glass marbles, was rolled over and over for several hours (see Fig. 1). Among the more promising toxic materials were dinitro-ortho-cresol (DN-o-C), supplied by Standard Agricultural Chemicals, Inc.; dinitro-ortho-cyclohexyl-phenol from Dow Chemical Co.; and ammonium-dinitro-ortho-cresylate and guanidine dinitro-ortho-cresylate from American Cyanamid & Chemical Corporation. Diluents included 320 mesh sulphur from Stauffer Chemical Co.; "Pyrophyllite" from E. I. du Pont de Nemours & Co.; and "Pyrite" from Dow. Other compounds, such as sodium arsenite, were pure chemicals available from laboratory stock.

The outstanding toxicity of 3,5-dinitro-ortho-cresol, as demonstrated by Decker and Drake (3), when compared with 24 other dinitro compounds, was the incentive for using the DN-o-C as the main toxic agent when these investigations were begun. Preliminary tests with other compounds were inserted in the program as the chemicals became available from the manufacturers.

There is some disagreement regarding the correct naming of the dinitro-ortho-cresol. Insect toxicologists generally refer to it as the 3,5-compound, but Filbert (5), of du Pont de Nemours & Co., states that 4,6-dinitro-o-cresol is the correct numbering as approved both by Chemical Abstracts and Beilstein.

EXPERIMENTAL ANIMALS

Dermacentor variabilis (Say) is a widely distributed American dog tick. It is implicated in transmission and dispersal of Rocky Mountain spotted fever. The number of infested specimens usually runs from 1 in 200 to 1 in 600 (16). In certain areas of Iowa it has sometimes been numerous enough (4) to be a potentially dangerous carrier of spotted fever to human beings.

Adult specimens of *D. variabilis* were collected by hand from dogs, or by "flagging" in those localities of Iowa where ticks of this species were known to be numerous. Ticks thus obtained were kept over moist sand in cotton-stoppered vials. These collections included ticks of all ages within their adult life span. Also, individuals ranged through all stages of nutrition, including full engorgement, interrupted feeding, and starvation. In some cases the period of starvation may have been for more than a year. In addition, the collections sometimes included spent females, or gravid females that began to oviposit while under observation as control or experimental subjects. In short, these adult ticks were of wild stock and possessed both the good and bad characteristics of an heterogeneous population.

Larval ticks were hatched from eggs deposited in the laboratory by females taken in the field. Larvae of a known age were thus available for tests. Other larvae were allowed to feed on white-footed mice, *Peromyscus leucopus noveboracensis* (Fischer), and, after transformation to nymphs, established a source of nymphs of known age.

Egg masses were collected in the laboratory, and tests were made of some of the dinitrophenols as tick ovicides.

METHODS

Not the least of the problems this investigation involved was that of devising some technique of bringing the ticks and the compounds together in a simple procedure that could be easily and reasonably duplicated. After various trials, the following set-up

and technique were employed for adult ticks: A circular opening, 6 inches in diameter, was cut in a piece of cardboard resting on a sheet of paper toweling. A 2-inch disk of cardboard was placed in the center of the 6-inch opening. Over the opening was placed a dusting tower consisting of a tall bell jar with an opening near the bottom, through which a dusting nozzle could be inserted (see Fig. 1). Known weights of dust were pumped into the tower while the nozzle was shifted about, inside the apparatus, to insure as even a distribution of dust as possible. After the dust settled, the tower was lifted away, and the entire cardboard pattern was removed. A 2-inch circular band of dust was thus formed on the toweling. Ticks to be tested were placed in the central dust-free area, and then recaptured outside the dust ring after voluntarily walking across it to the outer dust-free area.

With nymphal ticks, the band of dust was reduced to 1 inch by merely using a 4-inch disk to make the inner dust-free surface. Younger larval ticks were so small and "bogged down" so easily in the dust ring that a further modification was necessary. For all larvae, therefore, the following uniform procedure was used. A small nontoxic dust ring of pyrophyllite was first set up. The test larvae were set free inside this ring. The dust tower was then set in place and the dust blown in. When the tower was removed the dusted larvae were picked up and then confined to vials.

Adult ticks and larger nymphs were easily handled with tweezers. Larval ticks were moved about on the pointed tip of a moistened brush.

After treatment, adult and nymphal ticks were confined separately in small vials and examined at regular, convenient intervals. Death of the specimen was recorded when no movement whatsoever was elicited even in the close approach to warmth from a light bulb. Larval ticks were usually kept in groups of 5 or 10 individuals to the vial.

All untreated controls were kept in the same type of container and under the same conditions as the treated ticks.

Actual determinations of the weight of dust distributed in the ring under the dust tower gave a quantity equivalent to about 65 to 75 pounds an acre for the adult and nymph treatments. For larvae, the quantity was about 20 to 25 pounds an acre.

RESULTS AND DISCUSSION

All results presented throughout this paper represent data collected under controlled laboratory conditions. Under no circumstances are they to be construed as results to be expected with field trials. It was the intention to carry on field operations during 1942, but by the time these preliminary laboratory tests were completed, the season suitable for outdoor tests was too far advanced. Since these present results may be of value to other workers who could make field runs before we can in the summer of 1943, our data are presented now. In any event, field trials will be conducted in Iowa in 1943 if the necessary equipment and labor can be assembled.

Fig. 1.—In the background is the tall bell jar used as a dusting tower. A charge of dust is suspended in its interior. In the foreground is the mixing-mill used to roll the dust mixtures.

Although test specimens were often kept under observation for a week or more, and controls were checked for several weeks at least, only the 24- and 48-hour mortality percentages are presented here. From the standpoint of toxicological interest, the 24- and 48-hour results are probably of most significance. Beyond 48 hours other factors than the exposure to the test dust are likely to come into play. Also, if a tick is a vector of a disease, the faster it is eliminated the better, if no other complications are involved.

Adult Dog Ticks

One of the first facts that became clearly evident in the results was the difference in resistance to DN-o-C between unfed and engorged adult ticks. This characteristic is demonstrated in the sample of data presented in Table 1.

TABLE 1.—MORTALITY OF UNFED AND ENGORGED ADULT DOG TICKS (*Dermacentor variabilis*) AFTER CONTACT WITH DINITRO-O-CRESOL DILUTED WITH PYROPHYLLITE

Nutritional state	DN-o-C	Number tested	Dead at 24 hours	Dead at 48 hours
	Percent		*Percent*[1]	*Percent*[1]
Unfed.....	2	20	35	35
Unfed.....	4	20	40	45
Unfed.....	8	50	64	68
Unfed.....	12	50	72	88
Engorged....	8	50	36	36
Engorged....	12	50	45	45

[1] Throughout this entire paper, percent of mortality is expressed in the nearest whole number.

Additional evidence that the nutritional state of these ticks is an important consideration was demonstrated in the summary of mortality of specimens of this species kept as controls under laboratory conditions. This summary is given in Table 2.

TABLE 2.—MORTALITY OF ADULT CONTROL SPECIMENS OF *Dermacentor variabilis*

Nutritional state	Number observed	Dead at 24 hours	Dead at 48 hours
		Percent	*Percent*
Unfed.....	180	11	17
Engorged.....	65	3	4

The high mortality of the unfed individuals is rather striking, and no explanation can be offered. Unfavorable humidity is probably a factor under laboratory conditions, even though some efforts were made to keep the test ticks from dehydration. So little is known regarding certain limiting ecological factors in the tick's life history that some of our colony-maintenance procedures were probably faulty. Under the pressure of present conditions, however, it was decided not to take time to explore these rearing problems, but to proceed to the more important toxicological aspects.

In regard to the high mortality, difference in the nutritional conditions is naturally the first suggested clue, but more complicated relationships may be involved. No attempt was made to check the life span of individuals under field conditions, but there is no reason to assume that such a high mortality among adults is a natural one. When one considers, also, that most unfed ticks were collected by the "flagging" method, which entails only slight chances of injury, while the engorged specimens were often dislodged with considerable difficulty from the skin of their hosts, the difference in mortality of the two types is even less easily explained. Nevertheless, in spite of the high death rate of unfed controls, the data of Table 1 show a good gradient of effect through the use of increased strengths of the dinitro-o-cresol.

Just what parts body surface and body volume, considered separately or together, might have in effecting the difference in mortality of unfed and engorged ticks is also unknown. Engorged ticks generally picked up considerably more of the chemical while walking through the band of dust. However, this factor of actual greater contact by swollen engorged ticks apparently was not sufficient to counteract the relatively larger amount of dust which the unfed ticks acquired. The ratio of body surface to body volume would, of course, be higher in the unfed ticks. The smaller, unengorged specimens could thus acquire a higher internal concentration of the absorbed poison, even though the actual contact was less.

TABLE 3.—MORTALITY OF UNFED AND ENGORGED ADULT DOG TICKS AFTER CONTACT WITH SULPHUR-DILUTED DINITRO-ORTHO-CRESOL

Nutritional state	DN-o-C	Number tested	Dead at 24 hours	Dead at 48 hours
	Percent		*Percent*	*Percent*
Unfed.....	4	100	57	65
Unfed.....	8	50	73	77
Unfed.....	12	50	60	68
Unfed.....	20	135	91	94
Unfed.....	25	110	87	98
Engorged...	4	25	16	28
Engorged...	8	50	42	60
Engorged...	12	25	47	80
Engorged...	25	70	51	96

When ordinary 320-mesh dusting sulphur was substituted for pyrophyllite as a diluent for the dinitro-ortho-cresol, a rather well-

marked general trend of increased toxicity was often noted, especially in the lower concentrations of DN-o-C. These data are given in Table 3 (compare with Table 1).

Tests with 100 per cent, 320-mesh sulphur in the 2-inch circular band of dust served to emphasize again the difference in susceptibility of unfed and engorged ticks. This information is found in Table 4.

TABLE 4.—TOXICITY OF 100 PERCENT SULPHUR (320 MESH) TO THE ADULT DOG TICK

Nutritional state	Number tested	Dead at 24 hours	Dead at 48 hours
		Percent	*Percent*
Unfed	120	19	27
Engorged	25	3	3

Weather conditions at, and transportation difficulties to, the usual sites of collections sometimes made it impossible to obtain, at the right time, as large samples as were desired for tests. With larger numbers of individuals, the discrepancy in the 8 per cent and 12 per cent trials with unfed specimens of Table 3 might be eliminated. The small sample and the heterogeneous character of the field-collected ticks may also account for the lower mortality among the few engorged ticks tested with 100 per cent sulphur than among the larger sample of control ticks in Table 2. Comparison of per cent mortalities in Tables 1 and 3 shows, however, that the use of sulphur as a diluent is a valuable procedure, especially with unfed ticks. Similar trials with 100 per cent pyrophyllite showed no mortality percentage above that found for the controls.

No attempt was made to set up experiments to test for synergistic action in the sulphur and dinitro-ortho-cresol mixtures. Such tests are planned when next season's ticks become available.

Just before the 1942 tests had to be terminated because of increased seasonal difficulties in obtaining ticks, several other compounds were received from manufacturers, and preliminary tests were run with the few ticks then available. One of these chemicals, the ammonium dinitro-ortho-cresylate, has shown excellent promise with certain insects (8a) and other near relatives of ticks. Results from these compounds are in Table 5. Also included in this table are data from the use of sodium arsenite at 4 per cent and 100 per cent levels. These arsenite tests were included merely as reference and comparison points with a more familiar toxic dusting compound.

TABLE 5.—PRELIMINARY RESULTS WITH MISCELLANEOUS COMPOUNDS USED AS DUSTS ON UNFED ADULT DOG TICKS

Compound	Per-cent	Diluent	Number tested	Dead at 24 hours	Dead at 48 hours
				Percent	*Percent*
$NaAsO_2$	4	Pyrophyllite	25	8	20
$NaAsO_2$	100	—	25	64	92
Guanidine dinitro-o-cresylate	12	Sulphur	30	0	23
Ammonium dinitro-o-cresylate	12	Sulphur	30	87	94

Tables 1, 3, and 5 offer the opportunity to compare the toxicity of several of the compounds tested on unfed dog ticks. At the 12 per cent level, the ammonium dinitro-ortho-cresylate seems the most toxic of the tested materials. At the 4 per cent levels, the sodium arsenite has about half the mortality per cent of dinitro-ortho-cresol; and, when the latter was combined with sulphur, a 25 per cent concentration had approximately the same toxicity for unfed specimens as 100 per cent sodium arsenite. Guanidine dinitro-ortho-cresylate was the least toxic of the chemicals tried on adult dog ticks.

TABLE 6.—MORTALITY OF NYMPHAL DOG TICKS AFTER CONTACT WITH VARIOUS DN-COMPOUNDS DILUTED WITH SULPHUR

Age	Compound	Per-cent	Number tested	Dead at 24 hours	Dead at 48 hours
				Percent	*Percent*
5 days	DN-o-C	8	30	50	57
5 days	DN-o-C	12	35	63	66
5 days	DN-o-C	16	50	74	96
2 weeks	DN-o-C	8	50	62	72
2 weeks	DN-o-C	12	50	96	98
2 weeks	DN-o-C	16	30	100	—
3 weeks	DN-o-C	8	30	97	97
3 weeks	DN-o-C	12	75	98	98
3 weeks	DN-o-C	16	50	100	—
3 weeks	Guanidine-DN-o-cresylate	12	30	33	60
3 weeks	Ammonium-DN-o-cresylate	12	80	100 (in 3½ hrs.)	—

Nymphal Dog Ticks

As stated previously, some larval ticks were allowed to feed in the laboratory on caged wild white-footed mice, and then used after transformation to the nymphal stage. All the data secured from tests on nymphs are set up in Table 6.

Several series of untreated, control nymphs were set up at the same time. Their data appear in Table 7.

TABLE 7.—MORTALITY OF UNTREATED NYMPHAL DOG TICKS

Age	Number observed	Dead at 24 hours	Dead at 48 hours
		Percent	*Percent*
5 days	30	0	0
2 weeks	50	4	22
3 weeks	30	13	28

One of the first facts apparent from Tables 6 and 7 is the decreased vigor of the nymphs as they become older. This point is demonstrated not only in the increased mortality of the controls, but also in the greater susceptibility to treatment with poisons. Table 6 also shows a regular progressive build-up in toxicity as the percentage of dinitro-o-cresol is increased. All nymphs were laboratory reared and were thus a stock of more nearly homogeneous test animals whose history was better known than that of the field-collected adults. Consequently, discrepancies in resultant data are not so likely to occur because of differences in age, nutrition, and other factors.

In addition, Table 6 makes it clear that of the two tested cresylates the guanidine compound is decidedly inferior to the ammonium dinitro-o-cresylate, and the latter is superior to the dinitro-o-cresol. While the 12 per cent dinitro-o-cresol attained 98 per cent mortality in 48 hours, the 12 per cent ammonium dinitro-o-cresylate brought about 100 per cent mortality in only three and a half hours.

TABLE 8.—MORTALITY OF 5-DAYS, 2-WEEKS AND 3-WEEKS OLD LARVAL DOG TICKS AFTER DUSTING WITH DINITRO-ORTHO-CRESOL DILUTED WITH PYROPHYLLITE

Age	Concentration of DN-o-C	Number tested	Dead at 1 hour	3 hours	6 hours	18 hours	24 hours	48 hours
	Percent		*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
5 days	0.063	30	33	87	100			
5 days	0.125	30	37	100				
5 days	0.25	30	100					
5 days	0.5	30	100[1]					
5 days	1.0	30	100[1]					
5 days	2.0	30	100[2]					
2 weeks	0.063	30	—	—	—	—	0	0
2 weeks	0.125	30	—	7	—	—	23	33
2 weeks	0.25	30	—	33	—	—	67	80
2 weeks	0.5	30	—	40	—	—	72	88
2 weeks	1.0	30	—	63	70	—	80	90
2 weeks	2.0	30	76	—	93	—	100	
3 weeks	0.5	30	—	13	33	37	37	37
3 weeks	1.0	30	47	—	67	70	70	73
3 weeks	2.0	30	57	—	70	73	73	77
3 weeks	4.0	30	100					

[1] In 55 minutes.
[2] In 20 minutes.

Larval Dog Ticks

A large supply of larval ticks made it possible to make runs through a longer series of concentrations at various ages of the test species. Trials were run at the following ages: 5 days, 2 weeks, 3 weeks, and 4 weeks. The first three ages were tested only with dinitro-o-cresol diluted with pyrophyllite. The 4-weeks larvae were tested after it was found that sulphur made a better diluent than pyrophyllite, and, unfortunately, it was not then possible to repeat the previous tests on younger larvae, using sulphur. Also, when the 4-weeks larvae were available, certain other chemicals were received and these were also tried. And, again, to our regret, it was not possible, last season, to use these latter compounds on other stages of ticks. Their data, however, are included as a matter of record of preliminary trials. Results on larval ticks will be found in the next two tables; a dash (—) in the body of the tables indicates that no check count for mortality was made at that particular time interval.

Contrary to the situation in nymphs, which seem to be less hardy with increasing age, Tables 8 and 9 show that larval ticks become more resistant as they get older. For example, at the 2 per cent level of dinitro-o-cresol the youngest larvae (5 days old) were all dead within 20 minutes; the 2-weeks specimens were all dead at 24 hours; and the three-weeks larvae had a mortality of 77 per cent at 48 hours. At 4 weeks of age, resistance increased to the point where 8 per

TABLE 9.—MORTALITY OF 4-WEEKS OLD LARVAL DOG TICKS AFTER DUSTING WITH VARIOUS COMPOUNDS

Compound	Concentration	Diluent	Number tested	Dead at 1 hour	Dead at 3 hours	Dead at 6 hours	Dead at 12 hours	Dead at 24 hours	Dead at 48 hours
	Percent			*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
DN-o-cresol	4	Sulphur	30	3	—	6	30	50	63
DN-o-cresol	8	Sulphur	30	10	67	90	—	100	
DN-o-cresol	12	Sulphur	30	13	97	100[1]			
DN-o-cresol	8	Pyrophyllite	30	80	100[2]				
DN-o-cresol	12	Pyrophyllite	30	97	100[2]				
DN-o-2nd butylphenol	8	Pyrophyllite	30	97	100[4]				
DN-o-cyclo-hexylphenol	8	Pyrophyllite	30	67	80	100[5]			
Dicyclohexyl-amine salt of DN-o-cyclo-hexylphenol	20	Pyrophyllite	30	3	20	—	57	100	
Dinitroso-resorcinol	100	—	30	3	6	—	100		
Tetrachlorophenol	100	—	30	33	100				
Pentachlorophenol	100	—	30	0	77	—	100		
Hexachlorophenol	100	—	30	6	57	—	100		
Sodium arsenite	4	Pyrophyllite	30	—	10	—	17	17	27
Sodium arsenite	100	—	30	73	87	100			

[1] In 5½ hours. [2] In 2½ hours. [3] In 1½ hours. [4] In 4½ hours. [5] In 8½ hours.

cent dinitro-o-cresol was necessary to give 100 per cent kill in 2½ hours; and with 12 per cent, 100 per cent mortality in 1½ hours.

Of the four other dinitrophenols listed in Table 9, two (the secondary butylphenol and the cyclo-hexylphenol) give promise of being as toxic as the dinitro-ortho-cresol, all tested at the 8 per cent level. The other two compounds (the amine salt and the resorcinol) were tested at much higher concentrations (20 per cent and 100 per cent, respectively) and showed no more toxicity for larval ticks than the 8 per cent DN-o-C.

All three of the -chlorophenols were tried without dilution, and, even at 100 per cent concentration, they were no more effective than DN-o-C in the range of 8 per cent and 12 per cent levels.

Two widely separated concentrations (4 per cent and 100 per cent) of sodium arsenite were tested on 4-weeks larvae, and just as in the case of unfed adult ticks (see Table 5), were considerably less effective than comparable percentages of dinitro-ortho-cresol.

The pronounced fragility of the young larval ticks is re-emphasized by the mortality data of controls, shown in Table 10. In this case, the high death rate of young larval ticks is probably a reflection of what occurs in nature also. When one compares

TABLE 10.—MORTALITY OF UNTREATED CONTROL LARVAL TICKS

Age	Number observed	Dead at 24 hours	Dead at 48 hours
		Percent	*Percent*
5 days	50	13	27
2 weeks	50	0	0
3 weeks	50	0	0
4 weeks	50	0	0

the large number of eggs, which each female tick produces, with the smaller number of ticks which reach maturity, it is evident that there must be some phase of post-hatching development during which survival is difficult. Toxic dust treatments may be able to utilize the lethal possibilities of this critical period.

Dog Tick Eggs

Two experiments were set up to test DN-o-C as a tick ovicide.

In the first test 15 clumps of eggs were placed under a bell jar and dusted with 12 per cent DN-o-C at the rate of about 50 pounds/acre. There was no noticeable decrease in hatching, after the usual incubation period.

In the second test 10 clumps of eggs were dusted in the same manner but with 25 per cent DN-o-C. After a sufficient incubation

period elapsed, the clumps were examined. There was an obvious reduction in the number of eggs that hatched, in comparison with undusted control clumps kept under the same laboratory conditions. Eggs at the bottom of the dusted clumps, those eggs not directly in contact with the 25 per cent DN-o-C, were the only ones which produced young ticks. Those dusted eggs on top and at the sides evidently were killed.

If these two rough tests are of any significance, they indicate a considerable resistance to toxic substances by tick eggs. In both of the above tests the dusts remained in contact with the eggs throughout the entire incubation time. Dusts applied under field conditions would probably not remain so closely applied during approximately three weeks of weathering. Attempts at eradication or decrease of ticks by dusting the eggs would probably not be practicable. It appears that the egg stage is not the tick's most vulnerable period.

CONCLUSIONS

On the basis of laboratory tests alone, the following statements are presented.

1. Unfed and engorged adult specimens of the American dog tick, *Dermacentor variabilis*, possess a decided difference in susceptibility to contact with dinitro-ortho-cresol and other dinitrophenols. For example, 12 per cent DN-o-C, with pyrophyllite as a diluent, applied at the rate of 65 to 75 pounds to the acre, has a 48-hour mortality of 88 per cent with unfed adults; and 45 per cent with engorged adults.

2. The use of 320-mesh dusting sulphur as a diluent, in combination with DN-o-C, makes a more toxic mixture against ticks than that obtained with pyrophyllite as the diluent. With 8 per cent DN-o-C, at 48 hours, the per cent of mortality for unfed adults is 68 per cent with pyrophyllite; 77 per cent with sulphur. For engorged adults, with 8 per cent DN-o-C, the per cent dead is 36 with pyrophyllite and 60 with sulphur.

3. Sulphur alone has some toxicity for unfed adult dog ticks. Applied at the rate of 65 to 75 pounds an acre, 100 per cent sulphur killed 19 per cent unfed ticks in 24 hours. It had no effect on the particular sample of 25 engorged specimens tested in the same manner.

4. Even in combination with sulphur, and at 65 to 75 pounds an acre, DN-o-C mixtures must contain at least 25 per cent of the DN compound to produce a kill over 95 per cent within 48 hours. The adult dog tick is tenacious of life.

5. Ammonium dinitro-o-cresylate gives promise of higher toxicity than DN-o-C. In preliminary tests, a 12 per cent concentration with sulphur is nearly equal in toxicity to 25 per cent DN-o-C when applied in identical dosages.

6. Undiluted sodium arsenite is slightly less toxic to unfed adult dog ticks than DN-o-C diluted at 25 per cent with sulphur, when applied in identical dosages, with identical technique.

7. Guanidine dinitro-ortho-cresylate does not show much promise as a tickicide.

8. Nymphal dog ticks decrease in vigor as they age during the nymphal stage. This is shown both by increased mortalities among untreated controls, and by greater susceptibility to dusting with DN compounds.

9. At 65 to 75 pounds an acre, a sulphur and DN-o-C mixture must contain at least 16 per cent of the cresol to kill more than 95 per cent of the younger (5 days old) nymphs within 48 hours. A 12 per cent DN-o-C will kill more than 95 per cent of 2 to 3 weeks old nymphs within 24 hours; 16 per cent kills 100 per cent in less than 24 hours.

10. With nymphal ticks ammonium DN-o-cresylate again shows superior toxicity; 12 per cent in sulphur kills 100 per cent of 3-weeks nymphs in 3½ hours.

11. Larval dog ticks become more hardy with age. For example, when treated with 2 per cent DN-o-C, 5 days old larvae were all dead in 20 minutes; the 2-weeks specimens were all dead at 24 hours; and 3-weeks larvae had a mortality of 77 per cent at 48 hours. At 4 weeks of age the DN-o-C concentration had to go to 8 per cent to kill 100 per cent in 24 hours.

12. When tested with 4-weeks old larval ticks, dinitro-o-secondary butylphenol and DN-o-cyclohexylphenol appear nearly as toxic as DN-o-C. The dicyclohexylamine

salt of DN-o-cyclohexylphenol is decidedly less toxic than DN-o-C.

13. Dinitrosoresorcinol, and the tetra-, penta-, and hexa-chlorophenols seem to have little value as tick larvicides.

14. Dog-tick eggs are quite resistant to poisoning by DN-o-C. When dusted with 12 per cent DN-o-C, no noticeable reduction in hatching occurred. Dusting with 25 per cent DN-o-C killed those eggs with which it came into direct contact, and on which it stayed during the entire incubation period.

15. With the above results in mind it seems an inevitable conclusion that field control of the American dog tick probably will be a difficult, but not impossible, problem if attacked with DN-o-C or NH_4-DN-o-cresylate. There seems to be no particularly vulnerable spot during its life history. It is most easily killed during early larval life, but that susceptibility does not help much, for practical purposes, since hatching occurs over a long period during warm weather. Only repeated dusting over several months could take advantage of this weakness.

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ENTOMOLOGY.—*Synoptic revision of the* testaceipennis *group of the beetle genus* Phyllophaga.[1]

LAWRENCE W. SAYLOR.

The specific name *testaceipennis* (Blanchard) has long been applied to various species of *Phyllophaga* resembling the true *testaceipennis*, all moderate-sized, semipruinose species with a foveate fifth sternite and *Phytalus*-like cleft claws (which are minutely denticulate beneath) having been combined under this name. The present paper attempts to clarify the taxonomy of this complex. Drawings of the genitalia of the species involved are here presented for the first time.

Six names have been proposed for species known to me that belong in the group, and of these two are here considered as synonyms. Two species are described as new, so that the group, as treated in this paper, comprises six valid species. The following key is based on the male sex; as the females (all except that of *raydoma*, n. sp., are known) are difficult to separate, they will have to be determined primarily by association with the males.

1. First two segments of hind tarsus of nearly equal length; elytral hair dense and very obvious, though short, and of nearly uniform length; fifth sternite not foveate; prothorax entirely and evenly punctate, with short, erect, obvious hair of uniform length (Fig. 6*a*, *g*). Guatemala.....*pubicollis* (Blanchard)

   First segment of hind tarsus very noticeably shorter than the second; elytral hairs variable but elytra never densely covered with short hairs; fifth sternite distinctly foveate or at least noticeably impressed apically; prothorax variably punctate but unevenly so, and middisk often irregularly impunctate, the hairs of variable length or lacking.....2

2. Fifth sternite densely punctate but distinctly not foveate apically, at most slightly transversely impressed; apex of fifth sternite straight and not at all emarginate.....3

   Fifth sternite densely punctate and very noticeably foveate, midapex distinctly and usually broadly and arcuately emarginate....4

3. Prothorax strongly shining, rufous, and glabrous or apparently so, the front angles sharp and subrectangular; antennal club slightly longer than funicle (Fig. 5*a*, *b*). British Honduras.....*bowditchi* Saylor

   Prothorax subpruinose, rufocastaneous, and with short hairs and some longer hairs intermixed, front angles obtuse and not particularly noticeable; antennal club distinctly longer than funicle and subequal to entire stem (Fig. 1*a*, *b*). Guatemala.....*raydoma*, n. sp.

4. Prothorax with hairs minute and hardly noticeable, without longer hairs; color dorsally distinctly pruinose (Fig. 3*a*, *b*, *f*). Panama, Venezuela.....*odomi*, n. sp.

   Prothorax always with noticeable hairs, these usually short, with intermixed longer hairs; color variable, either strongly shining or pruinose.....5

5. Color always very distinctly and very strongly shining, thorax deep rufous; elytra coarsely and rugosely punctate and without obvious striae (Fig. 4*a*). Costa Rica.....*sanjosicola* Saylor

   Color highly variable but always evidently pruinose, thorax at most castaneorufous; elytra less rugosely punctured and usually with distinct striae (Fig. 2*a–e*). Mexico to Panama.....*testaceipennis* (Blanchard)

Phyllophaga (Phyllophaga) testaceipennis (Blanchard)

Fig. 2, *a–e*

Ancylonycha testaceipennis Blanchard, Cat. Col. 1: 134. 1850.

Lachnosterna testaceipennis (Blanchard) Bates, Biol. Cent.-Amer. 2(2): 195. 1888.

Male: Form oblong-oval, wider behind. Color testaceous to rufotestaceous, varying to rufocastaneous or castaneopiceous, the thorax usually more rufous; above slightly to markedly pruinose, dorsal hair variable. Head with front convex, coarsely, rugosely and closely punctate with short erect hairs. Clypeus transverse, disk sparsely to moderately punctured, at times with smooth areas near the hardly impressed and faintly biarcuate suture; apex somewhat reflexed and hardly or not emarginate, the angles and sides not reflexed and the lateral angles so broadly rounded as to make the clypeal shape semiarcuate. Antenna variable, 9- or 10-segmented, usually the latter; the club small and thick and usually a little longer than, or subequal to, the funicle. Thorax with sides straight before the submedian, obtuse lateral dilation, and faintly emarginate behind it, the angles distinct but very obtuse; disk smooth, the punctures irregularly placed and separated

[1] Received January 27, 1943.

by 1 to 3 times their diameters, sparser at center disk, which often possesses an irregular impunctate area; all punctures with short erect hairs and a moderate number of intermixed much longer hairs, the discal surface at least partly pruinose. Scutellum impunctate. Elytral punctures more regularly placed and separated by 1½ to 3 times their diameters, with short suberect hairs and some longer ones intercalated, especially near suture and base; striae variable, usually irregular but obvious, the sutural striae strong. Pygidium convex, polished or semipruinose, the surface frequently slightly wrinkled, and the punctures sparse and separated by two to four times their diameters, with short suberect hairs; apex well rounded and ciliate. Abdomen polished and subflattened at middle, and the sutures obliterated between sternites 2 to 5, the disk very sparsely, finely, and setigerously punctate, the hairs short and suberect; fifth sternite with a large median patch of about three dozen granules, the apical half of segment foveate and the center apex *appearing* widely and somewhat deeply emarginate; sixth sternite nearly as long as fifth, flattened, sparsely set with fine granules and long erect hairs, and the middle disk with a distinctly impressed longitudinal sulcus. Claws very short and rounded, appearing narrowly cleft very much as in *Phytalus;* the middle tooth as long as the apical but twice as wide through its middle part, its apex reflexed basally; basal dilation obtuse and the surface between it and basal tooth minutely denticulate. Segments 1–4 of anterior tarsus each with a small though distinct spine on the inner apical angle. Hind spurs free, spinose, the longest a little longer than first tarsal segment; first tarsal segment only three-fifths the length of the second.

Female: Similar to male except: Antennal club shorter than funicle; pygidium distinctly narrowed and pointed at center apex, and reflexed slightly into a sharp tumosity, the margin hardly thickened, but the surface below the "point" and on the underside of the pygidium very wide and smooth, the disk with very short erect hairs; fifth sternite plane, hardly different from the fourth; sixth sternite convex and irregularly punctate, the center discal area impunctate; claws slightly longer and very distinctly more widely cleft (see Fig. 2*e*). Length 13–16 mm.

Described from Mexico, this is an extremely common and widespread species, ranging from Mexico to Panama. Since the original description of half a dozen lines is so inadequate the species is here described in some detail. Most closely related to *sanjosicola* Saylor and *odomi* Saylor, this species is readily separated by the key characters and the form of the male genitalia.

Phyllophaga (Phyllophaga) bowditchi Saylor

Fig. 5, *a–b*

Phyllophaga (*Phyllophaga*) *bowditchi* Saylor, Proc. Biol. Soc. Washington 51: 189–190. 1938.

This species is known to me only through the type series from "M-tee District of British Honduras, March." It most closely resembles *raydoma* Saylor of this species-complex, but the two species are noticeably different in all views of the male genitalia, as well as in the external characters noted in the key.

Phyllophaga (Phyllophaga) raydoma, n. sp.

Fig. 6, *a, b*

Male: Similar to *testaceipennis* (Blanchard) in most respects, differing only as follows: Antenna 10-segmented, the club long and subequal to the entire stem in length; scutellum very sparsely punctate; fifth abdominal sternite nearly flat, only faintly impressed apically and not at all foveate; first hind tarsal segment only one-half the length of the second; and the genitalia are different (see Fig. 1, *a–c*). Length 14 mm. Width 7.5 mm.

The unique male holotype in the Saylor collection is from "Alta Vera Paz, Guatemala." The species differs mainly from *testaceipennis* in characters of the antennal club, the fifth abdominal sternite, and the male genitalia.

Phyllophaga (Phyllophaga) odomi, n. sp.

Fig. 3, *a, b, f*

Male: Color rufotestaceous to rufocastaneous or rufopiceous, the thorax and head usually rufous or darker than the elytra; surface distinctly pruinose; dorsal surface variably hairy. Very similar in nearly all respects to *testaceipennis* except as follows: Clypeus at times more densely punctate and semitrapezoidal; thoracic hairs always *minute* and hardly or barely visible, *without* any longer intercalated hairs; elytral hairs also *minute*, with several short hairs

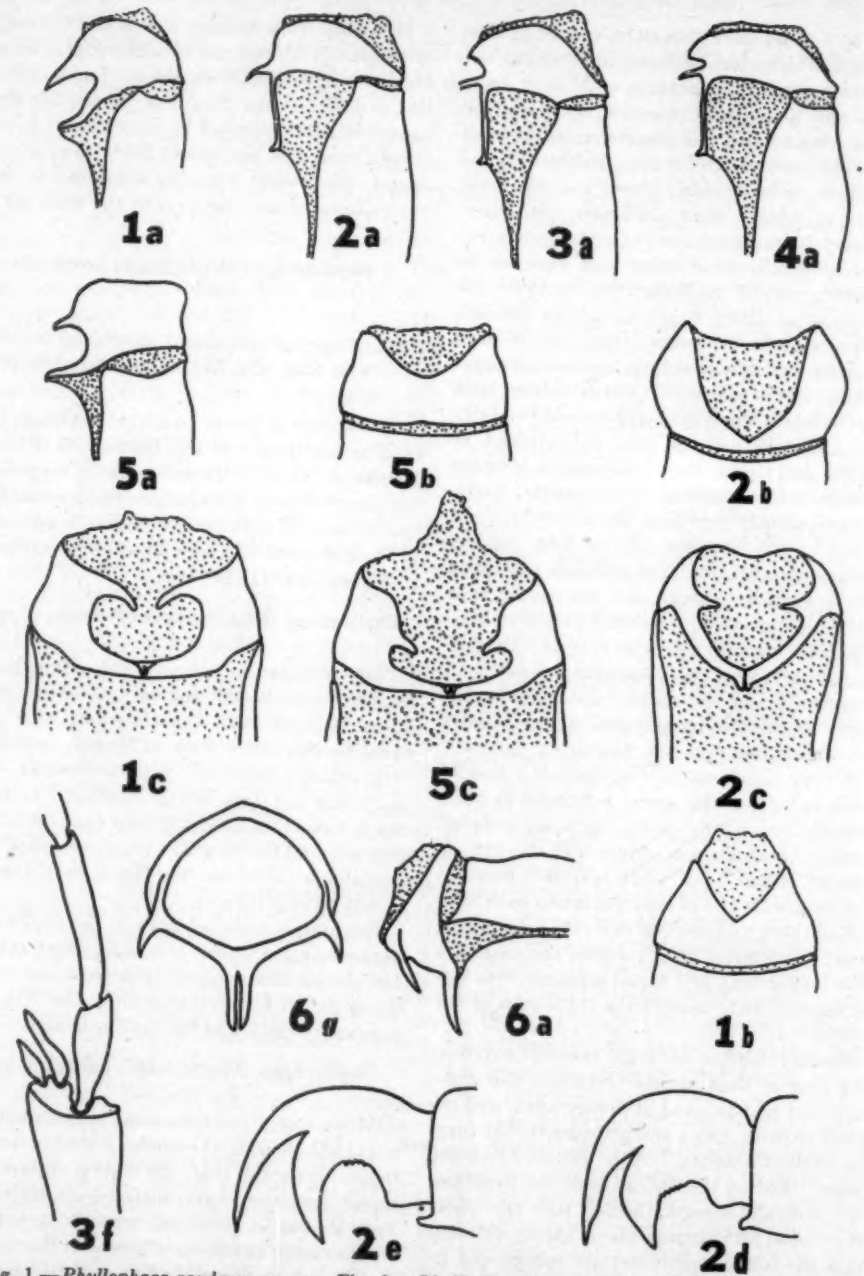


Fig. 1.—*Phyllophaga raydoma*, n. sp. Fig. 2.—*Phyllophaga testaceipennis* (Blanchard). Fig. 3.—*Phyllophaga odomi*, n. sp. Fig. 4.—*Phyllophaga sanjosicola* Saylor. Fig. 5.—*Phyllophaga bowditchi* Saylor. Fig. 6.—*Phyllophaga pubicollis* (Blanchard).

a, Lateral view of male genitalia; *b*, dorsal view of male genitalia; *c*, ventral view of male genitalia; *d*, front male claw; *e*, front female claw; *f*, ventral view of hind leg of male; *g*, en-face view of male genitalia.

adjoining the scutellum; genitalic form related to that of *testaceipennis*, but different, especially in lateral view (see Fig. 3, *a*).

Female: Similar to female of *testaceipennis* except that the thoracic hairs are all minute and hardly visible (in one female example of *odomi* about half a dozen long hairs are visible just before the midapex but the entire disk is minutely haired). Length 15–17 mm. Width 7–9 mm.

The male holotype is from "Madden Dam, Canal Zone, Panama, collected at light V-18-36 by M. M. Saylor"; the female allotype and several male and female paratypes are from "Los Canales, Kaiguata, Venezuela, VII-24-39, Vivas-Berthier Collector." An additional paratype is from "Caracas, Venezuela, D. F., VI-5-32." All are in the Saylor collection. I take pleasure in naming this handsome species for my close friend and collecting companion C. Ray Odom, of Virginia. *P. odomi* differs mainly from *testaceipennis* in the thoracic vestiture, larger size, and the slightly different male genitalia (which in lateral view appear to overhang slightly the upper tooth, but not so much as in *sanjosicola* Saylor).

Phyllophaga (Phyllophaga) sanjosicola Saylor
Fig. 4, *a*

Phyllophaga sanjosicola Saylor, Rev. Ent. 5(4): 500. 1935.

Phytalus valeriana Saylor, Pomona Coll. Journ. Ent. Zool., Dec. 1934.

Known as yet only from the type series, all the specimens of which were collected "at light, San José, Costa Rica, May, 1,000–1,200 m." This series is divided between the Saylor collection and the Nevermann collection, which is now in the United States National Museum. The slightly larger size, distinctive shining, and more coarsely punctate surface will readily separate the species from *testaceipennis*, as will also the male genitalia (uppermost portion of *testaceipennis* genitalia in lateral view evenly rounded above the upper tooth, whereas in *sanjosicola* the uppermost portion very markedly overhanging the upper tooth).

Phyllophaga (Phyllophaga) pubicollis
(Blanchard)
Fig. 6, *a–g*

Phytalus pubicollis Blanchard, Cat. Col. 1: 131. 1850.

Phytalus (?) pubicollis Blanchard, Bates, Biol. Cent.-Amer. 2(2): 126, 400. 1888.

Lachnosterna heynei Moser, Stett. Ent. Zeit., 1918: 164. (*New synonymy.*)

Male: Elongate, subparallel; color rufocastaneous and shining, the thorax and head shining rufous, above densely haired. Clypeus moderately long, the disk flat, sparsely and coarsely punctate, smooth near middle: apex subtruncate, unemarginate, and slightly reflexed, the angles very broadly rounded. Head with the front slightly convex, densely, coarsely and entirely punctate, with erect hairs of moderate length. Antenna 10-segmented, unicolorous castaneous, the club long and subequal to the entire stem. Thorax with the sides evenly arcuate and hardly dilated at middle, the margin entire and ciliate; angles very obtuse and not well marked; disk evenly and entirely punctured, the punctures separated by one and one-half to twice their diameters, with suberect short hairs, and many intermixed erect hairs of moderate length. Scutellum sparsely and setigerously punctured. Elytra punctate as thorax, with dense, short, semierect hairs and a few longer hairs near base; striae faintly indicated. Pygidium polished, convex, the disk coarsely and moderately densely punctate, with short suberect hairs and sparse, erect longer hairs, the apex subrounded, narrowed and slightly reflexed. Abdomen polished, faintly concave at middle, very sparsely and finely punctate and with short hairs (densely and more closely punctate at sides), and the sutures of sternites 2–5 effaced at middle; fifth sternite flattened, densely and coarsely punctate at middle, with a few small procumbent hairs; sixth nearly as long as preceding and transversely impressed, the disk finely and setigerously punctate and without any longitudinal sulcus, the hairs on disk long but nearly procumbent. Claws very short and cleft as in *testaceipennis* but the upper (i.e., closest to base) tooth 2½ times as wide at base as the apical tooth. Hind spurs free and very graceful; the first two hind tarsal segments subequal and the second only faintly the longest. Front tarsi slightly spinose on inner apical angles.

Female: Differs from male as follows: Antennal club subequal to funicle; pygidium small, plane, sparsely and not coarsely punctate, with short suberect hairs, the apex subrounded and narrowed and the apical fourth of disc some-

what smooth; abdomen semiconvex, the fifth sternites plane, and coarsely, densely punctate, the sixth convex and similarly punctate; claws distinctly more widely cleft; first segment of hind tarsus distinctly shorter than the second. Length 12.5 to 13 mm. Width 6–7 mm.

I have specimens from "Coban, Vera Paz, Guatemala, Conradt collector" (*Biologia* material), and also from "Alta Vera Paz, Guatemala." The species was very inadequately described from Mexico by Blanchard, who placed it in *Phytalus* because of the cleft claws; however, the female claws are so widely cleft that the species cannot be included there. As indicated in the key the species is abundantly different from the others in the group but appears to belong with them in most general characters. Bates first placed the species in *Phytalus* and later removed it to *Lachnosterna* in the *Biologia* Supplement.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

45TH ANNUAL MEETING OF THE ACADEMY

The 45th annual meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on January 21, 1943. President CURTIS called the meeting to order at 8:15 P.M., with about 80 persons present. The minutes of the 44th annual meeting were approved as published on pages 85 to 91 of the JOURNAL of March 15, 1942. The reports of the several officers and of the Committees of Auditors and Tellers were read and accepted, as follows:

Report of the Secretary

During the past year, 23 new members (14 resident and 9 nonresident) were taken into the ACADEMY. Three of the new nonresident memberships were in the honorary class. The new members were distributed among the various sciences as follows: 3 each in bacteriology and physics, 2 each in astronomy, chemistry, and geology, and 1 each in agronomy, anthropology, archeology, biochemistry, botany, geochemistry, geography, hydraulics, physiology, plant pathology, and plant physiology.

Because of retirement from active practice of their profession, 10 members (7 resident and 3 nonresident) were placed on the retired list. Resignations were accepted from 11 members in good standing (9 resident and 2 nonresident).

The deaths of 17 members (8 resident and 9 nonresident) were reported, as follows:

THOMAS HERBERT NORTON, White Plains, N. Y., December 2, 1941.
CLINTON HART MERRIAM, Berkeley, Calif., March 20, 1942.
WALTER FORD REYNOLDS, Baltimore, Md., May 1, 1942.
EDWARD CENTER GROESBECK, Washington, D. C., May 9, 1942.
SIR JOSEPH LARMOR, Cambridge, England, May 19, 1942.
MARCUS WARD LYON, JR., South Bend, Ind., May 19, 1942.
HENRY GRANGER KNIGHT, Washington, D. C., June 13, 1942.
ANDREW STEWART, Washington, D. C., June 28, 1942.
HARRY JOHN MCNICHOLAS, Washington, D. C. July 23, 1942.
THOMAS LEONARD WALKER, Toronto, Canada, August 6, 1942.
HENRY CORBIN FULLER, Washington, D. C., August 26, 1942.
ALFRED NELSON FINN, Lincoln, Nebr., September 21, 1942.
WILLIAM EDWARD PARKER, Fort Lauderdale, Fla., September 30, 1942.
ROBERT WILCOX SAYLES, Chestnut Hill, Mass., October 23, 1942.
CHARLES SCHUCHERT, New Haven, Conn., November 20, 1942.
HERMAN STABLER, Washington, D. C., November 24, 1942.
JAMES EDMUND IVES, Washington, D. C., January 1, 1943.

On January 20, 1943, the status of the membership was as follows:

	Regular	*Retired*	*Honorary*	*Patrons*	*Total*
Resident	423	37	3	0	463
Nonresident	132	20	15	2	169
Total	555	57	18	2	632

The net changes in membership during the past year are as follows:

	Regular	*Retired*	*Honorary*	*Patrons*	*Total*
Resident	−10	4	0	0	−6
Nonresident	5	2	2	0	9
Total	−5	6	2	0	3

From February 6, 1942, to January 11, 1943, the Board of Managers held eight meetings, with an average attendance of 19 persons. Two special committees held over from 1941 completed their work. Of the 10 special committees appointed by the president during the past year, 8 have completed their work.

During the past year, the Academy held six meetings, beginning with the 310th and ending with the 315th as follows:

On February 19, 1942, jointly with the Anthropological Society of Washington, with an address entitled *The Aztecs of Mexico* by GEORGE C. VAILLANT, director of the Museum of the University of Pennsylvania.

On March 19, 1942, for the presentation of the Academy's Awards for Scientific Achievement for 1941 to G. ARTHUR COOPER, of the U. S. National Museum, in the biological sciences; to THEODORE R. GILLILAND, of the National Bureau of Standards, in the engineering sciences; and to STERLING B. HENDRICKS, of the U. S. Bureau of Plant Industry, in the physical sciences.

On April 16, 1942, jointly with the Philosophical Society of Washington, with an address entitled *Cosmic emotion*, by PAUL R. HEYL, chief of the Section on Sound at the National Bureau of Standards.

On October 15, 1942, jointly with the Washington Branch of the Society of American Bacteriologists, with an address entitled *Structural differentiation within the bacterial cell as shown by the electron microscope*, by STUART MUDD, professor of bacteriology in the School of Medicine at the University of Pennsylvania.

On November 19, 1942, jointly with the Philosophical Society of Washington, with an address entitled *Color blindness and its relation to the detection of camouflage*, by DEANE B. JUDD, physicist in the Section on Photometry and Colorimetry at the National Bureau of Standards.

On December 17, 1942, jointly with the Anthropological Society of Washington, with an address entitled *Anthropological explorations in Netherlands New Guinea*, by MATTHEW W. STIRLING, chief of the Bureau of American Ethnology, Smithsonian Institution.

Accounts of the first four of these meetings have already been published in the JOURNAL under the Proceedings of the Academy, and those of the last two will appear shortly. All the meetings were held in the Assembly Hall of the Cosmos Club.

Respectfully submitted by FREDERICK D. ROSSINI, *Secretary*.

Report of the Treasurer

CASH RECEIPTS AND DISBURSEMENTS

RECEIPTS:	
From dues 1940	$ 20.00
From dues 1941	100.00
From dues 1942	2,570.00
From dues 1943	65.00
From subscriptions 1941	47.20
From subscriptions 1942	479.70
From subscriptions 1943	330.00
From sales of JOURNAL	69.60
From sales of directory	6.85
From payments for reprints	488.15
From interest on deposits	.90
From interest on investments	982.06
Total receipts	$5,159.46
Cash balance Jan. 1, 1942	4,802.97
To be accounted for	$9,962.43

DISBURSEMENTS:	
For Secretary's Office	$ 381.85
For Treasurer's Office	164.13
For JOURNAL printing 1941	242.75
For JOURNAL printing 1942	2,342.45
For JOURNAL reprints 1942	339.86
For JOURNAL illustrations 1941	40.63
For JOURNAL illustrations 1942	328.33
For JOURNAL Office 1941	20.74
For JOURNAL Office 1942	242.19
For Custodian & Subs. Mgr.	15.37
For Meetings Committee	286.98
For directory	30.84
For refund on JOURNAL sales	5.40
Total disbursements	$4,441.52
Bank debit memos:	
Subscriptions, 1942	13.95
Deposited in Savings Account	.90
	$4,456.37
Cash balance Dec. 31, 1942	1,506.06
	$5,962.43
Invested in U. S. Series G Bonds	4,000.00
Total	$9,962.43

RECONCILIATION OF BANK BALANCE

Balance as per cash book 12-31-42		$1,506.06
Bank Balance American Sec. & Trust Co., per statement 12-31-42	1,558.06	
Receipts not deposited	31.60	
	$1,589.66	
Checks outstanding, not cashed:		
No. 170	$21.50	
881	2.30	
882	25.00	
884	7.50	
885	4.80	
886	22.50	83.60
		$1,506.06

INVESTMENTS

409	Shares stock of Washington Sanitary Improvement Co., par value $10 per share, cost	$ 4,090.00
20	Shares stock Potomac Elec. Power Co., 6% Pref., cost	2,247.50
4	Certificates Corporate Stock of City of New York, 1 for $500, 3 for $100, cost	800.00
1	Bond of Chicago Railways Co., #1027; interest at 5%, due 1927, par value $1,000 less $250, cost	713.87
1	Real-estate note of T. Q. Donaldson (#6 of 12) dated June 26, 1937 (extended to 1943); interest 5%, cost	1,000.00
2	Real-estate notes of Yetta Korman et al., dated Oct. 5, 1938, for 3 years (#7 of 37 for $500 and #8 of 37 for $500), cost	1,000.00
2	Certificates (1 for $4,000 and 1 for $1,000) First Federal Savings & Loan Assn. Nos. 914 & 1063	5,000.00
2	Certificates (1 for $4,500 and 1 for $500) Northwestern Federal Savings and Loan Assn. Nos. 1380 and 1441	5,000.00
4	U. S. Government Series G Bonds at $1,000 each, Nos. M332990G, M332991G, M332992G, M332993G	4,000.00
	Deposited in Savings Account, American Sec. & Trust Co.	46.65
		$23,898.02
	Cash Book balance Dec. 31, 1942	1,506.06
	Total Assets	$25,404.08

Total Assets Dec. 31, 1942	$25,404.08
Total Assets Dec. 31, 1941	24,700.09
Increase	$ 703.99

After payment of outstanding bills, the net increase in assets for 1942 will be about $300.

ALLOTMENTS

	Allotted		*Expended*
Secretary's Office	450.00		381.85*
Treasurer's Office	200.00		164.13
JOURNAL	2800.00	+593.08 = 3393.08	3010.64**
Meetings Committee	325.00		324.98†
Custodian & Subs. Mgr.	75.00		27.37°
Membership Committee	10.00		
Executive Committee	10.00		
JOURNAL Clerical Asst.	240.00		
JOURNAL Misc. Expense	60.00	= 300.00	264.00°°
Addendum to Directory	60.00		30.84

*Does not include unpaid bill of approximately $10.00.
**Does not include, Oct., Nov. or Dec. Reprints nor Nov. or Dec. Printing & Illustrations.
†Includes all charges for 1942, $38.00 of which has been paid since Dec. 31, 1942.
°Includes all charges for 1942 $12.00 of which has been paid since Dec. 31, 1942.
°°Includes all charges for 1942 $21.91 of which has been paid since Dec. 31, 1942.

Respectfully submitted by HOWARD S. RAPPLEYE, *Treasurer*.

Report of the Committee of Auditors

The accounts of the Treasurer of the Washington Academy of Sciences for the year 1942 were examined by your committee on January 18, 1943. All receipts and imbursements included in his report were checked against all vouchers and balance sheets from the bank. Vouchers are properly approved and the report is correct. Securities listed in the Treasurer's reports were inspected on January 18, 1943, and the statement of assets is correct. The orderly manner in which the records were kept is to be highly commended and made the committee task an easy one.

Respectfully submitted by JOHN W. ROBERTS (*Chairman*), EUGENE POSNJAK, and C. H. SWICK.

Report of the Archivist

During the past year little progress has been made in sorting the material turned over to the Archivist. A 5-foot steel safe, a 3-drawer steel file with lock, and a steel storage cabinet have been borrowed for storing the archives. The archivist was authorized to open a mysterious package that had remained sealed since the founding of the Academy. This package contained the original ballots for charter members and is open for inspection by any who are interested. A noteworthy archive, found by Dr. L. O. Howard when he moved his household effects to New York, was given to the Archives. This was a large book containing reproductions of the signatures and documents incident to the formation of the Royal Society of London. Any material of value to the Academy in its Archives will be greatly welcomed by the Archivist from the members of the Academy.

Respectfully submitted by NATHAN R. SMITH, *Archivist.*

Report of the Board of Editors

Volume 32 of the JOURNAL for the calendar year 1942 consisted of 12 issues of 376 pages distributed as follows:

Classification	*Number of Articles*	*Number of Pages*	
Anthropology	2	18.3	
Astronomy	1	28.0	
Astrophysics	1	3.0	
Bacteriology	1	4.0	
Biophysics	2	10.1	
Botany	13	66.5	
Chemistry	5	21.2	
Crystallography	1	11.0	
Entomology	4	19.9	
Ethnology	1	17.0	
General Interest	2	14.9	
Geodesy	1	5.3	
Geology	1	2.3	
Geophysics	1	15.0	
Ichthyology	4	23.3	
Index	1	4.0	
Medical Entomology	1	3.0	
Obituaries	7	5.0	
Paleobotany	1	3.7	
Paleontology	2	10.4	
Proceedings—Academy		17.8	
Proceedings—Anthrop.		.9	
Proceedings—Chem.		2.1	
Proceedings—Geol.		6.0	
Proceedings—Phil.		7.3	
Physics	2	20.4	
Zoology	11	35.6	
Total			376.0

These may be summarized as follows:

Biological Sciences	43	211.8	56.3%
Physical Sciences	12	106.2	28.2%
General Interest	2	14.9	4.0%
Proceedings; Obit.		39.1	10.4%
Index		4.0	1.1%

This volume included three presidential addresses; 58 line cuts, and 17 halftones. Of the 55 papers, 33 (60.0%) were contributed by members of the Academy. The previous volume contained 62 articles of which 36 (58.1%) were by Academy members.

Two facts worth noting in the above figures are:

A. Volume 32 is the smallest volume ever issued by the Academy since the initial volumes. The following comparative figures, reduced approximately to the equivalent number of pages in the new format, may be of interest:

Average number of pages for the period 1932–1941	442
Average number of pages for the period 1915, 1916, 1918, 1919	539
Number of pages for 1917	485

The Board of Editors believes that the trend of the last decade culminating in the 376 pages for 1942 is undesirable and that publication in the JOURNAL should be stimulated.

B. The JOURNAL undoubtedly fills a need for the biological sciences (taxonomic articles), whereas it is not sought for the publication of articles in the physical sciences. Perhaps this fact is the underlying reason why the JOURNAL has been for some time secretly in disrepute among many Academy members. The Board of Editors believes that members of the Academy should contribute more original articles of their own.

The primary reason for the small size of the volume just published was not lack of material, however; on December 15 there were on hand 59 pages in proof and approximately 15 pages in manuscript. Volume 32 was restricted in content in order that the budget allotment for the JOURNAL might not be exceeded. A financial statement follows together with some comparative figures:

	Printing & Mailing	*Illustrations*	*Reprints*
Maximum 1930–1941	$3410.78	$500.70	$618.44
Minimum 1930–1941	2564.50	227.70	398.17
Average 1930–1941	2826.16	344.78	517.07
1941	2650.17	294.46	602.70
1942	2523.47	330.67	*(386.29)

* This amount includes only 10 months; bills for November and December reprints have not yet been received.

In 1942 authors, institutions, or societies paid the following amounts to cover the cost of excess illustrations, additional charges, and reprints (see the 1941 figures for comparison):

1941	168.85	90.18	344.55
1942	32.47	107.89	*(367.02)

The Editors' budget for 1942 was as follows (cf. 1941 figures for comparison):

	Printing, Illustrations, Reprints, and Mailing	*Clerical Assistance*	*Postage and Incidentals*
1941	$3100.00	$240.00	$60.00
1942	2800.00	240.00	60.00

The amounts charged to the Editors' accounts were as follows:

1941.....	2941.08	240.00	28.93
1942.....	2735.05	240.00	25.80

The unexpended balances are:

1941.....	158.92	0.00	31.07
1942.....	64.95	0.00	34.20

In addition to the *cut* in the Editors' budget there was a 6 per cent *increase* in printing charges by the George Banta Publishing Co. This resulted in an increase in cost of $58.06 for the last six months, or approximately $87.08 for the year 1942 (the increase began with the April issue). The following steps were taken to meet these financial problems:

A. The format of the JOURNAL was changed from a single column in 1941 to a double column in 1942. This resulted in a saving of $146.31 for the last six months, or approximately $292.62 for the entire year 1942.

B. The author's share in the cost of reprints was increased with the January issue; the practice of giving an author 50 free reprints was discontinued with the March issue. It is estimated that a saving of $187 was effected in this way.

C. Illustrations allowed an author were reduced from the equivalent of two pages of line-cut drawings to one page and a half with the May issue, and then further reduced to one page with the November issue. The full effect of the last reduction will not be felt until next year; that of the first reduction was estimated to be small.

D. Unusual costs of foreign, mathematical, and tabular materials, as well as alterations made in the proof by the author, were studied by the Editors. Whereas these may be small in comparison with the cost of illustrations individually, they may become excessive when totaled, as may be seen from the following charges to the Academy:

Additional Typesetting Charges	*1939*	*1940*	*1941*	*1942*
Foreign material.....	$68.82	$68.70	$75.19	$114.56
Tables.....	24.55	77.95	96.75	109.34
Mathematical material	67.08	20.12	113.87	26.96
Other Type Charges..	67.05	76.92	61.61	83.21
Alterations.....	107.15	99.60	101.60	93.99

It is evident that an article without illustrations, but with sufficient typesetting changes, may cost the Academy more than one with illustrations, but with few typesetting changes. The Board of Editors has taken steps to limit the total additional charges to the Academy. Members of the Academy can assist in this economy by preparing their own manuscripts with greater care and by insisting upon the same carefulness in articles that they communicate.

The Board of Editors wishes to express its appreciation of the excellent editorial assistance of Mr. PAUL H. OEHSER. His services have made possible a more uniform JOURNAL, as well as a more efficient editorial routine with resulting financial gain to the Academy. The Senior Editor is grateful for the willing cooperation of the other members of the Board of Editors and also of all the Associate Editors.

Respectfully submitted by G. ARTHUR COOPER, JASON R. SWALLEN, and RAYMOND J. SEEGER, *Senior Editor.*

Report of the Custodian and Subscription Manager of Publications

STOCKS OF PUBLICATIONS

The stocks of the Academy's publications have shown an increase during the year due to continued donations from various sources accompanied by a very small number of sales. As shown in the appended inventory there are 26 reserve sets (eight sets of vols. 1–30 of which one is incomplete, lacking but six numbers, seven sets of vols. 1–30 and 11 sets of vols. 16–30). Most of this reserve, together with the miscellaneous stocks including all of vols. 1–22, is stored in Washington, while the chief supplies of vols. 23–32 are stored with the printer at Menasha, Wis.

INVENTORY OF STOCKS OF PUBLICATIONS— DECEMBER 31, 1942

(Except where noted these are stored in Washington, D. C. in storage provided without cost by the Smithsonian Institution and by the U. S. Coast and Geodetic Survey)

Proceedings of the Washington Academy of Sciences:

Volumes 1–13 inclusive.....	50 Sets

Reserve sets of the Journal of the Washington Academy of Sciences:

Bound volumes 1–29+vol. 30 unbound.....	1 Set
Unbound volumes 1–30 (complete).	6 Sets*
Unbound volumes 1–30 (incomplete, lacking 6 nos).....	1 Set*
Unbound volumes 1–30.....	7 Sets*
Unbound volumes 16–30.....	11 Sets*

* Some numbers at Menasha.

Nonreserve volumes of the Journal of the Washington Academy of Sciences (in Washington):

Vol.	*No. Vols.*	*Vol.*	*No. Vols.*
5.....	2	19.....	11
6.....	2	20.....	10
7.....	5	21.....	56
8.....	4	22.....	49
9.....	3	23.....	4
10.....	2	24.....	12
11.....	9	25.....	14
12.....	7	26.....	19
13.....	11	27.....	21
14.....	6	28.....	11
15.....	10	29.....	23
16.....	19	30.....	29
17.....	14	31.....	7
18.....	13		

Also miscellaneous collection of odd numbers of the Proceedings, the JOURNAL, the Directory (1897 to 1941 inclusive), and reprints of special articles.

SUBSCRIPTIONS

Owing to the international situation the subscriptions as well as sales of publications have been curtailed.

Nonmember subscriptions in United States	103
Nonmember subscribers in foreign countries	28
Nonmember subscribers (inactive) in enemy-controlled areas	31
Subscriptions Geological Society of Washington	13

EXPENDITURES

Because conditions have not warranted the expenditures anticipated the amount actually used has been but $27.37 of the budget allowance, leaving an unexpended balance of $47.63.

Respectfully submitted by WILLIAM W. DIEHL, *Custodian and Subscription Manager of Publications.*

Report of the Committee of Tellers

The Committee of Tellers met on January 16, 1943. A total of 230 ballot envelopes were delivered to the Committee by the Secretary. Of these, 1 bore no signature and 3 bore the signature of a member in arrears. In the remaining 226 envelopes there were found 206 ballots on the Amendments to the Constitution and 219 ballots for Officers and Managers of the Academy.

The count of the ballots on the Amendments showed the following results:

Amendment No.	*1*	*2*	*3*	*4*	*5*	*6*
For amendment	193	198	202	200	205	205
Against amendment	11	6	2	3	0	0
Not voting	2	2	2	3	1	1

The count of the ballots on Officers of the Academy showed the following results:

	For	*Against*	*Not Voting*
For President, LELAND W. PARR	214	0	5
For Secretary, FERDINAND G. BRICKWEDDE	215	0	4
For Treasurer, HOWARD S. RAPPLEYE	213	0	6

Examination of the preferential ballot for Managers by the Hare system showed 1 unmarked ballot and 33 ballots that were invalid because marked with crosses from which no first choice could be determined, leaving 185 valid ballots. The Droop Quota was therefore $(185+1)/(2+1)=62$. The count of the ballots showed the necessary quotas for FREDERICK D. ROSSINI and JOHN E. GRAF.

Respectfully submitted by WALTER RAMBERG, *Chairman*, LEWIS W. BUTZ, PAUL S. ROLLER.

Election of Vice-Presidents

For the respective affiliated societies, the Secretary presented the following nominations for Vice-Presidents of the Academy:

Philosophical Society of Washington: RAYMOND J. SEEGER
Anthropological Society of Washington: FRANK M. SETZLER
Biological Society of Washington: HARRY B. HUMPHREY
Chemical Society of Washington: HERBERT L. HALLER
Entomological Society of Washington: AUSTIN H. CLARK
National Geographic Society: ALEXANDER WETMORE
Geological Society of Washington: CLARENCE S. ROSS
Medical Society of the District of Columbia: FRED O. COE
Columbia Historical Society: ALLEN C. CLARK
Botanical Society of Washington: CHARLOTTE ELLIOTT
Washington Section of the Society of American Foresters: WILLIAM A. DAYTON
Washington Society of Engineers: FRANK B. SCHEETZ
Washington Section of the American Institute of Electrical Engineers: FRANCIS B. SILSBEE
Washington Section of the American Society of Mechanical Engineers: WALTER RAMBERG
Helminthological Society of Washington: EMMETT W. PRICE
Washington Branch of the Society of American Bacteriologists: RALPH P. TITTSLER
Washington Section of the Institute of Radio Engineers: HARRY DIAMOND
Washington Section of the American Society of Civil Engineers: OWEN B. FRENCH

The Secretary was instructed to cast a unanimous ballot for these nominees.

Awards for Scientific Achievement for 1942

President CURTIS announced the recipients of the Academy's Awards for Scientific Achievement for 1942, as follows:

For the Biological Sciences, to—

ROBERT S. CAMPBELL, assistant chief of the Division of Range Research of the U. S. Forest Service, in recognition of his distinguished service in range research, particularly in the development of range utilization standards.

For the Engineering Sciences, to—

WALTER RAMBERG, senior physicist in the Section on Engineering Mechanics at the National Bureau of Standards, in recognition of his distinguished service in research on the static and dynamic strength of structural elements, particularly in relation to aircraft.

For the Physical Sciences, to—

MILTON HARRIS, director of research for the Textile Foundation and for the Textile Research Institute, both having laboratories at the National Bureau of Standards, in recognition of his distinguished service in conducting fundamental research on the composition and properties of textile fibers.

After a recess during which the 316th meeting of the Academy (see below) was held, President CURTIS appointed Past Presidents CHAMBLISS and CRITTENDEN to escort the new President, L. W. PARR, to the Chair. After a short address, President PARR adjourned the meeting.

316TH MEETING OF THE ACADEMY

The 316th meeting of the Academy was held in the Assembly Hall of the Cosmos Club immediately following the 45th annual meeting of the Academy on January 21, 1943. President CURTIS called the meeting to order and explained the nature of the program arranged for this meeting. Reports on governmental publication of scientific research were presented by ATHERTON SEIDELL for the U. S. Public Health Service, by MELVIN C. MERRILL and RALPH SHAW for the U. S. Department of Agriculture, and KASSON S. GIBSON for the National Bureau of Standards. Censorship of scientific publications going abroad was described by EDWARD D. HILL, of the U. S. Board of Economic Warfare. Open discussion followed these reports, and ATHERTON SEIDELL presented the following statement for the consideration of the Academy:

"The Washington Academy of Sciences recommends that: Research papers originating in governmental laboratories and describing additions to scientific knowledge be published in Federal journals devoted to specific fields of scientific research and that these journals be issued at regular intervals and at subscription rates approximately sufficient to cover their cost. The present method according to which many individual agencies publish occasional bulletins or composite collections of papers in many fields of science is not in the opinion of the Academy the most effective method of distributing the information contained in the reports."

No action was taken on this recommendation.

FREDERICK D. ROSSINI, *Secretary*

CHEMICAL SOCIETY

545TH MEETING

The 545th meeting was held jointly with the District of Columbia Section of the American Society of Civil Engineers in the main auditorium of the U. S. Chamber of Commerce on Tuesday, September 22, 1942, at 8:15 P.M. FRANK HOWARD, president of the Standard Oil Development Co., spoke on *The manufacture and use of synthetic rubber.*

546TH MEETING

The 546th meeting was held at the George Washington University on Thursday, October 8, 1942, at 8:15 P.M. At the conclusion of the general meeting, the following divisional meetings were held:

Biochemistry, M. X. SULLIVAN, *presiding*

The inorganic constituents of bone. S. B. HENDRICKS and W. L. HILL (Bureau of Plant Industry).

The catalase activity of the tissues of tumor-bearing animals. JESSE P. GREENSTEIN (National Cancer Institute).

Heat-labile, avidin-uncombinable, species-specific vitamers of biotin. DEAN BURK and R. J. WINZLER (National Cancer Institute).

Canine cystinuria. Urinary excretion of cystine following the administration of homocystine, homocysteine, and some derivatives of cystine and cysteine. W. C. HESS and M. X. SULLIVAN.

Organic chemistry, H. P. WARD, *presiding*

The structure of diketene. FRANCIS O. RICE (Catholic University of America).

Optical rotation as a measure of aromatic substitution influences. WARD PIGMAN (National Bureau of Standards).

4-Methyl-d-mannose and some of its derivatives. W. T. HASKINS, RAYMOND M. HANN and C. S. HUDSON (National Institute of Health).

Physical chemistry, B. D. VAN EVERA, *presiding*

The polymorphism of phosphoric oxide. W. L. HILL, G. T. FAUST, and S. B. HENDRICKS (Bureau of Plant Industry).

The influence of molecular size on the properties of cellulose acetate. MILTON HARRIS and ARNOLD SOOKNE (Textile Foundation).

Measurement of mositure in gases by electrical conductance at different pressures. E. R. WEAVER (National Bureau of Standards).

Inorganic and analytical chemistry, ROLLIN E. STEVENS, *presiding*

The use of phosphate for the separation of cobalt from iron. VICTOR NORTH and R. C. WELLS (Geological Survey).

Radium content of certain ultrabasic rocks. GORDON L. DAVIS (Geophysical Laboratory).

Determination of active oxygen in the presence of lead and barium. MICHAEL FLEISCHER (Geological Survey).

Chemical and physical properties of leather. PHILIP E. TOBIAS (National Bureau of Standards).

547TH MEETING

The 547th meeting was held at the Cosmos Club on Thursday, November 12, 1942, at 8:15 P.M. MAX BERGMANN, of the Rockefeller Institute for Medical Research, spoke on *The speci-*

fic action of proteolytic enzymes: Current problems and recent advances.

548TH MEETING

The 548th meeting was held at the Cosmos Club on Thursday, December 10, 1942, at 8:15 P.M. GUSTAV EGLOFF, technical director of the Universal Oil Products Co., addressed the society on *Substitute fuels in a world at war.*

E. R. SMITH, *Secretary.*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington at its annual meeting on January 19, 1943, elected the following officers: President, GEORGE S. DUNCAN; Vice President, REGINA FLANNERY; Secretary, WILLIAM N. FENTON; Treasurer, T. DALE STEWART; Members of the Board of Managers, W. H. GILBERT, H. W. KRIEGER, JULIAN H. STEWARD, J. E. WECKLER, W. R. WEDEL.

A report of the membership and activities of the Society since the last annual meeting follows: Life members, 2; active members, 41; associate members, 11; total, 54.

The members elected during the year were: Rev. GERALD DESMOND, Miss JENNY REITSMA, WILLIAM H. SPINKS, active members; Mrs. WILLIAM H. SPINKS, associate member.

Two active members, CARL W. BISHOP and JOHN G. CARTER were lost by death. The Society voted to record its deep sense of loss at the death of these members and to extend its sincere condolences to their relatives.

The Treasurer's report is as follows:

Funds invested in Perpetual Building Association (with interest to date)	$1,702.84
21 shares Washington Sanitary Improvement Co. (par value $10 per share)	210.00
2 shares Washington Sanitary Housing Co. (par value $100 per share)	200.00
U. S. Savings Bond, Series G	500.00
Cash in bank	263.66
	$2,876.50
Bills outstanding:	
To American Anthropological Association .....$40.	40.00
	$2,836.50
Total as of January 19, 1942	2,679.94
Increase	$ 156.56

Division of annual surplus

	Previous	*1943*	*Total*
Publication fund	$50.04	52.18	102.22
Speakers fund	50.04	52.19	102.23
Investment fund	50.05	52.19	102.24

The Society acted as host to the American Anthropological Association on the occasion of the annual business meeting of the latter on December 28, 1942, at the Cosmos Club.

It was voted that the Anthropological Society of Washington affiliate with the Inter-American Society of Anthropology and Geography.

Papers presented before the regular meetings of the Society were as follows:

January 20, 1942, 704th meeting, JOSEPH E. WECKLER, *Cundiyo, a Spanish village in New Mexico.*

February 19, 1942, 705th meeting, held jointly with the Washington Academy of Sciences, G. C. VAILLANT, *The Aztecs of Mexico.*

March 17, 1942, 706th meeting, ALFRED MÉTRAUX, *The Jesuits in South America.*

April 21, 1942, 707th meeting, address of retiring President, FRANK M. SETZLER, *Archeological accomplishments during the past decade in the United States* (this JOURNAL, 32(9): 253–259. Sept. 1942).

October 20, 1942, 708th meeting, DOUGLAS L. OLIVER, *Ethnography on Bougainville, Solomon Islands.*

November 17, 1942, 709th meeting, FROELICH G. RAINEY, *Anthropology and the Alaska-Canada Highway.*

December 17, 1942, 710th meeting, held jointly with the Washington Academy of Sciences, MATTHEW W. STIRLING, *Anthropological explorations in Netherlands New Guinea.*

WILLIAM N. FENTON, *Secretary.*

Obituaries

HERMAN STABLER'S untimely death in Washington on November 24, 1942, brought profound sorrow and a sense of irreparable loss to the Federal Service, the engineering profession, and his community. Of English descent and Quaker parentage, Herman Stabler was born on February 3, 1879, at Brighton, Montgomery County, Md. His early elementary education was followed by one year at Pacific College, Newburg, Oreg., and four years at Earlham College, Richmond, Ind., where he developed a bent for chemical and civil engineering and received the B.S. degree in 1899. After a year of special engineering study at Columbian (now George Washington) University, Washington, D. C., he served for the ensuing two years as instructor in mathematics and surveying at the National Correspondence Institute in that city.

In December 1903 Stabler entered the Federal service as a hydrographic aid in the Hydrographic (now Water Resources) Branch of the Geological Survey and until 1909 was engaged in studies of stream pollution, water quality, and effect of suspended matter on silting of streams in various parts of the country. While in the Reclamation Service in 1909–10 he completed a systematic study of the waters likely to be used on reclamation projects throughout the West to determine the influence of salinity on vegetable growth and the probable rate of silting in future reservoirs and canals. During these studies he devised a method of classifying waters for industrial purposes from analytical data expressed ionically, in parts per million, that is still widely used.

In 1911 Stabler became a member of the division of hydrographic classification in the newly created Land Classification Branch, thereafter succeeding N. C. Grover as chairman in June 1913, becoming assistant chief in 1920, and succeeding W. C. Mendenhall as branch chief in November 1922. In this period he became intimately acquainted with the natural resources of the West and the problems of their development through his direction of the extensive field and office investigations required to determine the power value and reservoir possibilities of streams in public-land States and the suitability of public lands for designation under the enlarged homestead acts of 1909 et seq., and the stock-raising homestead act of 1916. He participated actively thereafter in the formulation of Federal policies affecting the use of public lands and the conservation of their natural resources, and assisted materially in organizing the work and procedure of the Federal Power Commission at its beginning in 1920.

On July 1, 1925, Stabler became chief of the Survey's Conservation Branch, created on that date to coordinate and carry on jointly the functions of land classification, theretofore discharged by the Land Classification Branch, and the work of supervising operations for mineral production from public and Indian lands pursuant to the Federal mineral-leasing laws, theretofore done by the Bureau of Mines. To this position, which he retained to the day of his death, he brought a broad perspective on western problems. He was responsible in no small part for legalizing the entry by Federal oil and gas lessees into agreements with each other or with others for the unit or cooperative development of oil and gas fields containing Government lands; for the replacement of the prospecting-permit system of disposing of Federal oil and gas lands with a straight leasing system; for requiring the measurement of oil from Federal and Indian lands on a 100-per cent basis less actual impurities instead of an arbitrary 96- or 97-per cent basis that assumed the difference to be impurities; for the assessment of compensatory royalty to offset drainage of oil or gas from Federal lands through wells on adjoining non-Federal lands; and for litigation, seeking to establish the right in the Secretary of the Interior to determine the value for royalty purposes of oil produced under Federal leases and disposed of at prices incompatible with its actual worth.

Indicative of his character and the variety of his interests was his confession a few months before his death that the most memorable and satisfying experiences of his life were his marriage, November 1, 1905, to Bertha R. Buhler, of Washington, D. C., who survives him; his participation in the topographic survey of Colorado River as a member of the Survey's Grand Canyon Expedition in 1923; his admission to the hole-in-one club at the Columbia Country Club, Chevy Chase, Md.; and his service as a director of the American Society of Civil Engineers from 1935 to 1937.—JOHN D. NORTHROP

FRANK DAWSON ADAMS, a corresponding member of the ACADEMY, died on December 26, 1942, after a brief illness, at his home in Montreal, Canada.

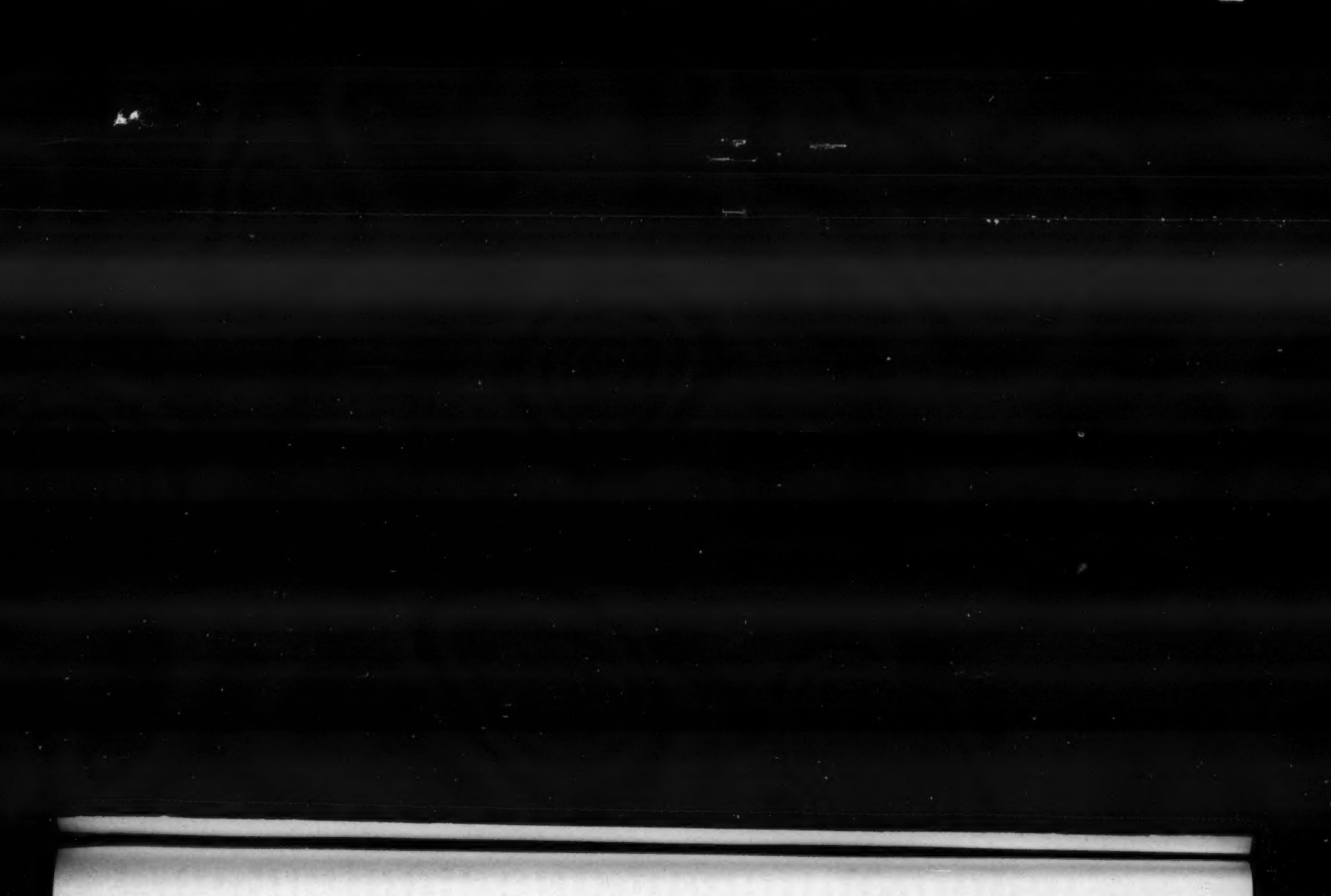
Dr. Adams was born on September 17, 1859, in Montreal; he was graduated from McGill University with first rank honors in natural science in 1878, and, under the inspiration of Sir William Dawson, chose geology as his major subject. He continued his studies at Sheffield Scientific School, Yale University, at Heidelberg, Germany, where he obtained the Ph.D. degree "summa cum laude" in 1892, and at Zürich.

He joined the Geological Survey of Canada in 1880 and continued with that service until he was appointed lecturer in geology at McGill University in 1889. Four years later, upon the retirement of Sir William Dawson, Dr. Adams was appointed Logan professor of geology and head of the department. He became dean of the faculty of applied science in 1908, and later vice-principal of McGill University and dean of the faculty of graduate studies and research.

Contemporaneous with his academic work, Dr. Adams was very active in geological fieldwork and research, and approximately 90 papers were published in leading scientific journals in America and Britain as a result of his investigations. His experimental work on the flow of rocks was carried out over a period of years, and the results contributed largely to the clarification of geological thought on metamorphism in the earth's crust, the depth of the zone of flow, and on the study of ore deposits.

Dr. Adams was the recipient of many academic honors, among which were honorary degrees from Bishop's College, Tufts College, University of Toronto, Queen's University, McGill University, and Mount Allison University. A mere list of some of his distinctions marks the man as outstanding among his fellows: fellow of the Geological Society of America, 1888; fellow of the Geological Society of London, 1895; recipient of the Lyell medal of the latter Society, 1906; fellow of the Royal Society of London, 1907; president of the Canadian Institute of Mining and Metallurgy, 1910–11; president, International Congress of Geologists, 1913; president, Geological Society of America, 1918; president, Royal Society of Canada, 1913; honorary member, Institution of Mining and Metallurgy; honorary member, American Institute of Mining and Metallurgical Engineers; honorary member, Engineering Institute of Canada; foreign associate, National Academy of Sciences, U.S.A.; corresponding member, New York Academy of Sciences; correspondent of the Academy of Sciences of Philadelphia; correspondent, Natural History Society of Ekaterinburg, Russia; member, American Philosophical Society; corresponding member, Geological Society of Stockholm; foreign honorary member, American Academy of Arts and Science; honorary member, Mineralogical Society of Russia; honorary member, Geological Society of Belgium; honorary member, Seismological Society of America; honorary member, Academia Asiatica, Teheran, Persia; foreign member, Swedish, and now Royal Swedish, Academy of Science.

Dr. Adams was a man of broad culture and wide travel. For some years after his retirement from active university work he traveled to libraries all over the world to accumulate the basic material for his important book *The birth and development of the geological sciences*, his last major contribution.

Interests as wide as his learning led him to take an active and leading part in the affairs of Rotary, the Boy Scouts, the Y.M.C.A., the Day Shelter for Unemployed Men, and other equally significant organizations. He was a devoted Anglican and was greatly interested in the welfare of the Church. A conclusion may be made in the words of Dean Dixon, who knew Dr. Adams intimately: "Few men have accomplished so much in a quiet unobtrusive way. The thing about his life that impresses me is the sense of completion which takes away the sting of death."

J. J. O'NEILL